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ABS FLEET SURVEY - PHASE II

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July 2000

GROUPE CARTIER

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16. Abstract

This report results from a project entailing a survey of Canadian fleets operating ABS equipped heavy vehicles to obtain data on their in-service experience with these systems. The survey was conducted through a written questionnaire.

This survey is the second phase of a Fleet Survey of Heavy Vehicle ABS Operation. The time elapsed between the first and second survey was designed to allow ABS technology to come into more common use and to determine whether increased fleet experience with ABS would lead to changes in the way fleets perceived ABS technology.

The overall objective of the survey was to determine truck and bus fleet operators' general perception of ABS performance, benefits and costs. The survey focussed on the following aspects of operator experience:

- Operational performance and durability of ABS
- Accident reduction and potential adverse effects of ABS
- Availability of ABS parts, service, and technical support
- Vehicle and ABS maintenance
- Cost impact of ABS

The questionnaire generated responses from 11 fleets, from various regions of Canada, operating a total of some 7,500 non-ABS and 1,200 ABS units, travelling respectively an average of 90,000 km and 75,000 km during the period covered by the survey.

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16. Resume

Ce rapport rend compte d'une enquête menée auprès de sociétés canadiennes de transport exploitant des véhicules lourds équipés d'ABS, afin de recueillir leurs commentaires concernant leur expérience pratique de ces systèmes. Les entreprises participantes devaient répondre par écrit à un questionnaire.

Cette enquête constitue la deuxième phase d'une Enquête sur l'exploitation de véhicules lourds équipés d'ABS. Le laps de temps entre la première enquête et la deuxième visait à permettre à la technologie ABS de gagner du terrain. Les chercheurs souhaitaient également déterminer dans quelle mesure une plus grande expérience des systèmes ABS avait pu modifier l'appréciation des entreprises de transport.

L'objectif global de l'enquête était de recueillir les commentaires généraux des exploitants d'autobus et d'autocars sur la performance, les avantages et les coûts des systèmes ABS. Voici quelques aspects abordés par l'enquête :

- Performance en service et durabilité des systèmes ABS
- Diminution du taux d'accident et effets indésirables potentiels des systèmes ABS
- Accessibilité des pièces, des services et du soutien technique concernant les systèmes ABS
- Maintenance des véhicules et des systèmes ABS
- Effets des systèmes ABS sur les coûts

Onze sociétés de transport des quatre coins du Canada ont répondu au questionnaire. Ensemble, elles exploitaient quelque 7 500 véhicules non équipés d'ABS et 1 200 véhicules équipés d'ABS, qui avaient parcouru respectivement 90 000 km et 75 000 km, en moyenne, pendant la période visée par l'enquête.

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SUMMARY

This report results from a project entailing a survey of Canadian fleets operating ABS (Antilock Braking System) equipped heavy vehicles to obtain data on their in-service experience with these systems. The survey was conducted through a written questionnaire.

This survey is the second phase of a Fleet Survey of Heavy Vehicle Antilock Braking System (ABS) Operation. The first survey covered the period from June to November 1995 and the results were published in a report entitled "Survey of Fleet Experience with Heavy Vehicle ABS Operation", TP 12710E (Transportation Development Centre, April 1996). This second survey is intended to cover the period from January to June 1997. The time elapsed between the first and second survey was designed to allow ABS technology to come into more common use and to determine whether increased fleet experience with ABS would lead to changes in the way fleets perceived ABS technology.

The overall objective of the survey was to determine truck and bus fleet operators' general perception of ABS performance, benefits and costs. Consequently, it focused on the following aspects of operator experience:

- Operational performance and durability of ABS
- Accident reduction and potential adverse effects of ABS
- Availability of ABS parts, service and technical support
- Vehicle and ABS maintenance
- Cost impact of ABS

The questionnaire generated responses from 11 fleets, from various regions of Canada, operating a total of some 7 500 non-ABS and 1 200 ABS units, travelling respectively an average of 90 000 km and 75 000 km during the period covered by the survey. The main conclusions supported by the survey results are as follows:

- Fleet operators appear to have a generally positive perception of ABS as useful, reliable, durable and relatively trouble-free equipment that is more and more frequently installed on new vehicles and is becoming a trucking industry standard.

- In terms of road safety, respondents to the survey acknowledge that ABS reduces vehicle-stopping distances in an emergency and increase vehicle stability during braking.

- The availability of ABS parts, service and technical support is generally perceived by fleet operators as good to excellent. Only one respondent rated these elements as poor to very poor.

- Survey respondents estimated the cost impacts of ABS as follows:
    - Increase in unit purchase prices: 2-5%.
    - Increase in unit maintenance costs: 0-1% and 2-5% each by an equal number of respondents
    - Increase in total vehicle operating costs: approximate average of 1%.

SOMMAIRE

Ce rapport résulte d'un projet qui consistait essentiellement à mener un sondage auprès de parcs canadiens de véhicules lourds équipés de systèmes ABS (technologie antiblocage), afin d'obtenir des données quant à leurs expériences opérationnelles avec ces systèmes. L'enquête s'est déroulée au moyen d'un questionnaire écrit.

Cette enquête est la deuxième phase d'un sondage sur les freins antiblocage (ABS) pour poids lourds. La première s'est intéressée à la période comprise entre les mois de juin et novembre 1995, et les résultats ont été publiés dans un rapport intitulé *Survey of Fleet Experience with Heavy Vehicle ABS Operation*, TP 12710E (Centre de développement des transports, avril 1996). Cette deuxième enquête cible la période allant de janvier à juin 1997. Le délai écoulé entre les deux sondages avait pour but de permettre une utilisation plus répandue de la technologie ABS, et ainsi de déterminer si l'expérience acquise par les exploitants de parcs de véhicules munis de cette technologie pourrait modifier la perception des transporteurs face à la technologie ABS.

L'objectif global du sondage consistait à cerner la perception générale des exploitants de parcs de véhicules utilitaires face au rendement de la technologie ABS, de même que les avantages et les coûts s'y rattachant. Par conséquent, le sondage a porté principalement sur les aspects suivants :

- performance opérationnelle et durabilité de la technologie ABS
- réduction des accidents et effets contraires potentiels de la technologie ABS
- disponibilité des pièces, du service et du soutien technique
- entretien des véhicules et de la technologie ABS
- impact de la technologie ABS sur les coûts

Le questionnaire a été rempli par onze parcs, provenant de diverses régions du Canada, et exploitant un total de quelque 7 500 unités munies d'un système de freinage conventionnel et 1 200 unités dotées des dispositifs ABS. Ces véhicules ayant parcouru une distance d'environ 90 000 km et 75 000 km, respectivement, au cours de la période ciblée par le sondage. Les principales conclusions corroborées par les résultats du sondage sont les suivantes :

- Les exploitants de parcs semblent, de façon générale, avoir une perception positive des dispositifs ABS, les jugeant utiles, fiables et relativement peu exigeants, et qui sont de plus en plus souvent installés sur les véhicules neufs, en plus de devenir une norme dans l'industrie du camionnage;

- Pour ce qui est de la sécurité routière, les répondants reconnaissent que les dispositifs ABS réduisent les distances de freinage en cas d'urgence, et augmentent la stabilité des véhicules lors du freinage;

- Les exploitants de parcs de véhicules lourds jugent de bonne à excellente la disponibilité des pièces pour les dispositifs ABS, le service et le soutien technique. Un seul répondant a qualifié ces éléments de pauvres à très pauvres;

- Les répondants au sondage évaluent l'impact de la technologie ABS sur les coûts de la façon suivante :

    - augmentation du prix d'achat des véhicules : 2 à 5 %
    - augmentation des coûts d'entretien : 0 à 1 % et 2 à 5 % chacun par un nombre égal de répondants
    - augmentation des coûts totaux d'exploitation d'un véhicule : moyenne approximative de 1 %

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1.0 INTRODUCTION

This document constitutes the final report of a project titled "Survey of Fleet Experience with Heavy Vehicle ABS" conducted by the Cartier Group, consultants, for the Transportation Development Centre of Transport Canada during the last quarter of 1997 and the first quarter of 1998.

This survey is the second phase of a Fleet Survey of Heavy Vehicle ABS Operation. The first survey covered the period from June to November 1995 and the results were published in a report titled "Survey of Fleet Experience with Heavy Vehicle ABS Operation", TP 12710E (Transportation Development Centre, April 1996). This second survey is intended to cover the period from January to June 1997. The time elapsed between the first and second survey was designed to allow ABS (Antilock Braking System) technology to come into more common use and to determine whether increased fleet experience with ABS would lead to changes in the way fleets perceived ABS technology.

The project entailed a survey of fleets operating ABS-equipped heavy vehicles to obtain data and information on their in-service experience with these systems.

The subsequent chapters of this report provide:

- A description of the characteristics of the survey conducted under this project in terms of its objectives, the methods utilised to obtain information and the criteria used to select respondents.

- The survey findings in relation to:

    - Fleet characteristics and use of vehicles
    - Driver opinions of ABS systems
    - Operational durability and safety performance of ABS
    - Maintainability of ABS
    - Impact of ABS on vehicle operating costs.

- The conclusions and recommendations derived from the analysis of the survey findings.

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2.0 SURVEY CHARACTERISTICS

The "Fleet Survey of Heavy Vehicle ABS Operation" project is part of ongoing Transportation Development Centre programs designed to address vital issues in highway freight transportation and road safety. This specific project is focused on antilock braking equipment, which has the potential to significantly improve safety, and its impact on motor carriers as perceived by fleet operators on the basis of their in-service experience of these systems.

2.1 Survey Objectives

The objective of the survey was to determine truck and bus fleet experience with ABS technology as it relates to vehicle braking performance and relative accident rates as well as system performance, durability, maintainability and impact on vehicle operating cost.

As was the case with the Phase 1 study, the survey was to determine the general perception of fleet operators of ABS performance, benefits and costs on the basis of their in-service experience.

2.2 Survey Questionnaire

The first phase of the project, conducted in 1995-96, focused exclusively on the trucking industry. For this second phase, the survey also included the bus industry. The questionnaire used for the Phase 1 survey was modified to address specific matters not covered in the Phase 1 survey. Two questionnaires were developed: one for the trucking industry and the other for the bus industry. Pre-selected truck and bus fleet operators were sent printed questionnaires contained in Appendix A. Their two main features were as follows:

- To ensure respondent willingness to participate in the survey, the surveys were designed to be simple to complete: space for answers was pre-formatted and multiple-choice questions were used.

- To allow respondents to provide all the information that they considered pertinent to the survey and to fully express their opinions, the questionnaires provided space for additional "comments and information".

2.3 Survey Respondents

A list of potential respondents in the trucking industry as well as in the bus industry was developed, based on the documentation available from Phase 1, from Transport Canada and from contacts with bus, truck and trailer manufacturers as well as from ABS manufacturers. These potential respondents were then contacted by phone in order to assess their willingness to participate in the survey.

The initial aim of the project was to survey a representative sample of 15 fleets (truck and bus) and, as a result of this limitation, not all potential respondents in Canada were asked to participate. Consequently, absence of any given fleet from the list of respondents should not be considered as an indication of its refusal to participate in this survey.

With regards to the truck fleets, questionnaires were sent out by mail to the companies that indicated they would participate in the survey. A total of eighteen companies were contacted by mail and it then required a close follow-up. To obtain a valid number of completed questionnaires, further phone calls were made and some questionnaires were filled directly by phone. Finally, a total of nine respondents completed the survey.

With regards to the bus fleets, specific transit and intercity bus companies were contacted by phone in early 1998 only to reveal that a majority did not operate ABS-equipped vehicles or that they had just begun introducing ABS-equipped vehicles in their fleets. A second attempt was made in early 1999 to obtain responses from the bus fleet operators as well as additional truck fleet operators. Of the eight bus fleet operators contacted, five agreed to participate; however, only two respondents returned completed questionnaires. No additional truck fleet operators submitted questionnaires.

The list of participating fleets is provided in Appendix B.

The principal characteristics of the respondents are as follows:

- All participating truck fleets, except one, operate between 40 and 400 ABS-equipped units.
- All participating bus fleets operate between 1 and 6 ABS-equipped units.
- The regional distribution of respondents is as follows: Maritimes 1; Quebec 4; Ontario 3; West 3.

3.0 SURVEY FINDINGS

This chapter provides, both in summarised text form and in detailed table form, the responses obtained from the participating fleets to the written questionnaire. Whenever applicable, a comparison with Phase 1 survey results is given in the tables.

3.1 Fleet Characteristics

The detailed information obtained from respondents is provided in Table 1. This information can be summarised as follows:

Trucks:

- Number of Heavy Vehicles in Fleet

  - The nine respondents to the survey constitute an aggregate sample of 8 782 units of which 1 214 or 13.8% are ABS-equipped. This is a slight increase over the 11.1 % of the 11 230 units that were covered for the Phase 1 survey.

  - ABS equipment is substantially more common on tractors (736 of 2 331 units or 31.6%) than on heavy trucks (44 of 382 units or 11.5%) and semi-trailers (417 of 5 988 units or 7.0%). Consequently, it appears that many units are being operated in an ABS (tractor)/non-ABS (trailer) configuration. In comparison with the previous survey, there is an increase in the use of ABS equipment in tractors and semi-trailer vehicles. However, the findings also indicate a decrease in ABS-equipped heavy trucks. This decrease could be attributed to the difference in total number of heavy trucks found in the two surveys.

- Tractor/Trailer Combinations

  The findings indicate that the most common combination is that of ABS-equipped tractors pulling conventional braking trailers. This combination accounts for more than 61% of any of ABS combinations while the ABS-equipped tractors pulling ABS-equipped trailers account for approximately 29% of any ABS combinations, and the conventional brake equipped tractors pulling ABS-equipped trailers account for approximately 10% of any ABS combinations.

Buses:

- Number of Heavy Vehicles in Fleet

  - The two respondents to the survey constitute an aggregate sample of 40 units of which 17.5% are ABS-equipped. Unfortunately, a more precise representation was not possible with the small sample obtained.

  - Six of the seven ABS-equipped units are of the mini-bus configuration.

Table 1
FLEET CHARACTERISTICS

TRUCKS:

Question # 2.1 Number of Heavy Vehicles in Fleet

		RESPONDENTS									TOTALS	TOTALS PHASE 1
		A	B	C	D	E	F	G	H	I		
Heavy Trucks	Conventional Braking	20		300				18			338	451
	ABS-equipped	10		25				9			44	95
Tractors	Conventional Braking	3	130	50	400	40			972		1 595	2 092
	ABS-equipped	50	40	25	50	40	97		254	180	736	843
Semi-Trailers	Conventional Braking	40	500	40	1 200	120	545	160	2 566	400	5 571	7 047
(Excluding A and B trains)	ABS-equipped	105		20	10	130			152		417	294
A-Train trailers	Conventional Braking	2			6						8	42
	ABS-equipped											
B-Train trailers	Conventional Braking			15	7	5		29			56	351
		8						9			17	15
Other	Conventional Braking											
	ABS-equipped											
Totals	Conventional Braking	65	630	405	1 613	165	545	207	3 538	400	7 568	9 983
	ABS-equipped	173	40	70	60	170	97	18	406	180	1 214	1 247

Question # 2.2 Tractor/Trailer Combinations

	RESPONDENTS									AVERAGE
	A	B	C	D	E	F	G	H	I	
ABS-equipped tractors pulling ABS-equipped trailers	70%		15%	10%	40%			5%	5%	18 1%
ABS-equipped tractors pulling conventional braking trailers	25%	25%	15%	30%	10%	100%		5%	95%	38 1%
Conventional brakes equipped tractors pulling ABS-equipped trailers			10%	30%	10%					6 3%
Conventional brakes equipped tractors pulling conventional braking trailers	5%	75%	60%	30%	40%			90%		37 5%

Note: Respondent G's answer was ignored due to inconsistency

BUSES:

Question # 2.1 Number of Buses in Fleet

		RESPONDENTS		TOTALS
		J	K	
Intercity:				
Conventional	Conventional Braking		12	12
	ABS-equipped		1	1
Articulated	Conventional Braking			
	ABS-equipped			
Transit:				
Conventional	Conventional Braking	10		10
	ABS-equipped			
Low-Floor	Conventional Braking	11		11
	ABS-equipped			
Articulated	Conventional Braking			
	ABS-equipped			
Other	Conventional Braking			
	ABS-equipped	6		6
Totals	Conventional Braking	21	12	33
	ABS-equipped	6	1	7

3.2 Fleet Vehicle Use

The detailed information obtained from respondents is provided in Table 2. This information can be summarised as follows:

Trucks:

- Distance Travelled

  According to the responses, conventional braking units travel approximately 15% more distance than ABS-equipped units. However, Phase 1 survey indicates no significant differences in the distances travelled.

- Types of Products Hauled

  There does not appear to be any significant difference in the types of products hauled by ABS and non-ABS units. This finding is consistent with the results of Phase 1 survey.

- Types of Hauling Environments

  There does not appear to be any significant difference in the types of hauling environments for ABS and non-ABS units. These results are consistent with the findings of Phase 1 survey.

In general, the findings indicate no significant difference between ABS and non-ABS units with respect to the assignment of vehicles to specific operations. As was the case with the previous survey, the findings indicate that intercity environment accounts for more than 50% of the distance travelled by ABS-equipped units.

Buses:

- Distance Travelled

  - The findings indicate no significant difference between ABS and non ABS-equipped units.

Table 2
FLEET VEHICLE USE

TRUCKS:

Question # 9.1 Distances Travelled
(Average distance travelled by a typical fleet vehicle in the 6-month period)

		RESPONDENTS									AVERAGE	AVERAGE
		A	B	C	D	E	F	G	H	I		PHASE 1
Conventional Braking Units	x1000 km	80	88	125	120	90		20	94		88	99
ABS-equipped Units	x 1000 km	80	88	40	120	90		20	94	62	74	97

Note: Respondent F's answer was ignored due to inconsistency.

Question # 9.2 Types of Products Hauled
(As percentages of total distance travelled by all fleet vehicles)

		RESPONDENTS									AVERAGE	AVERAGE
		A	B	C	D	E	F	G	H	I		PHASE 1
General	Conventional Braking	10%	100%		100%	100%	100%	10%		100%	58%	47%
	ABS-equipped	10%	100%		100%	100%	100%	10%		100%	58%	46%
Bulk Solids	Conventional Braking								45%		5%	11%
	ABS-equipped								45%		5%	9%
Bulk Liquids	Conventional Braking	90%		100%					55%		27%	42%
	ABS-equipped	90%		100%					55%		27%	45%
Other	Conventional Braking							90%			10%	
	ABS-equipped							90%			10%	

Question # 9.3 Types of Hauling Environment
(As percentages of total distance travelled by all fleet vehicles)

		RESPONDENTS									AVERAGE	AVERAGE
		A	B	C	D	E	F	G	H	I		PHASE 1
Urban	Conventional Braking	20%	2%	50%	80%	40%			5%		25%	21%
	ABS-equipped	20%	2%	50%	80%	40%	25%		10%		28%	25%
Suburban	Conventional Braking	10%			20%				40%		9%	14%
	ABS-equipped	10%			20%				45%		10%	14%
Intercity	Conventional Braking	70%	98%	50%		60%	100%		55%	40%	59%	65%
	ABS-equipped	70%	98%	50%		60%	75%		45%	40%	55%	62%
Other	Conventional Braking									60%	7%	
	ABS-equipped									60%	7%	

BUSES:

Question # 9.1 Distances Travelled
(Average distance travelled by a typical bus in the 12-month period)

		RESPONDENTS		AVERAGE
		J	K	
Conventional Braking Units	x1000 km	35	60	48
ABS-equipped Units	x1000 km	40	60	50

Question # 9.2 Types of Operation
(As percentages of total distance travelled by all buses)

		RESPONDENTS		AVERAGE
		J	K	
Urban	Conventional Braking			
	ABS-equipped			
Suburban	Conventional Braking			
	ABS-equipped			
Intercity	Conventional Braking			
	ABS-equipped			
Charter	Conventional Braking		100%	50%
	ABS-equipped		100%	50%
Other	Conventional Braking			
	ABS-equipped	100%		50%

Question # 9.3 Types of Transportation Environment
(As percentages of total distance travelled by all buses)

		RESPONDENTS		AVERAGE
		J	K	
Urban	Conventional Braking			
	ABS-equipped			
Suburban	Conventional Braking			
	ABS-equipped			
Intercity	Conventional Braking			
	ABS-equipped			
Charter	Conventional Braking		100%	50%
	ABS-equipped		100%	50%
Other	Conventional Braking			
	ABS-equipped	100%		50%

3.3 Driver Experience and Training

The detailed information obtained from respondents is provided in Table 3. This information can be summarised as follows:

Trucks:

- Number of Heavy Vehicle Drivers with ABS Experience

  The findings indicate that over 92% of the 972 drivers are experienced with ABS. Over 51% of these drivers posses one to two years of experience.

- Driver Training Programs or Courses

  The survey indicates that five out of seven fleets provide their own theory and/or practice courses to drivers or through the vehicle supplier. Two fleets indicated that no training or courses are provided to their drivers.

Buses:

- Number of Bus Drivers with ABS Experience

  - Based on the small sample size, the survey indicates that over 87% of bus drivers have no ABS experience.

Table 3
DRIVER EXPERIENCE AND TRAINING

TRUCKS:

Question # 3 Number of Heavy Vehicle Drivers with ABS Experience

	RESPONDENTS									TOTALS
	A	B	C	D	E	F	G	H	I	
No experience with ABS				70						70
Less than 1 year of experience with ABS		20		200						220
1 to 2 years of experience with ABS	10	20		150		108	9		200	497
More than 2 years of experience with ABS	85			100						185
Total	95	40		520		108	9		200	972

Question # 4 Any Driver ABS Training Program or courses given, and who gave training

		RESPONDENTS									TOTALS
		A	B	C	D	E	F	G	H	I	
Given by company	Theory				X			X			2/7
	Practice		X					X	X		3/7
Given by ABS supplier	Theory										
	Practice										
Given by vehicle supplier	Theory										
	Practice					X					1/7
Given by others	Theory										
	Practice										
None				X						X	2/7

BUSES:

Question # 3 Number of Bus Drivers with ABS Experience

	RESPONDENTS		TOTALS
	J	K	
No experience with ABS	21	40	61
Less than 1 year of experience with ABS	6	3	9
1 to 2 years of experience with ABS			
More than 2 years of experience with ABS			
Total	27	43	70

Question # 4 Any Driver ABS Training Program or courses given, and who gave training

		RESPONDENTS	
		J	K
Given by company	Theory		
	Practice	X	
Given by ABS supplier	Theory		
	Practice		
Given by vehicle supplier	Theory		
	Practice		
Given by others	Theory		
	Practice		
None			X

3.4 Driver Opinions on ABS System

The detailed information obtained from respondents is provided in Table 4. This information can be summarised as follows:

Trucks:

- Driver Preference of Vehicle Combinations

  The survey results indicate that most of the drivers ranked ABS-equipped tractors pulling ABS-equipped trailers the highest, followed by ABS-equipped tractors pulling conventional braking trailers and conventional brake equipped tractors pulling conventional braking trailers. The combination conventional brake equipped tractors pulling ABS-equipped trailers is ranked the least preferred choice among drivers.

- Changes in Driver Braking Habits

  Approximately half of the respondents indicated that drivers changed their braking habits for ABS-equipped tractors pulling ABS-equipped trailers. Most of the respondents indicated no change in their braking habits for ABS-equipped tractors pulling conventional braking trailers or conventional braking tractors pulling ABS-equipped or non ABS-equipped trailers.

- Improvements in Vehicle Braking Characteristics

  Respondents indicated almost unanimously that ABS improves braking characteristics for any tractor/trailer combinations and improves vehicle stability mainly for ABS-equipped tractors. Fifty percent of the respondents judge that conventional braking tractors pulling ABS-equipped trailers have improved vehicle stability.

Buses:

- Driver Preference of Vehicle Combinations

  It is difficult to evaluate the breaking system preference among drivers considering the small number of respondents. However, respondent J indicated a definite preference for an ABS-equipped fleet of mini-buses for the transport of passengers with wheelchairs.

- Changes in Driver Braking Habits

  Both respondents expressed divergent views as to changes in braking habits with ABS-equipped units. The likely reason for this may be attributed to the size of the vehicle driven.

- Improvements in Vehicle Braking Characteristics

  Both respondents indicated improved braking and vehicle stability with ABS.

Table 4
DRIVER OPINIONS ON ABS SYSTEM

TRUCKS:

Question # 5 Ranking of Vehicle Combinations according to Driver preference

		RESPONDENTS									TOTALS
		A	B	C	D	E	F	G	H	I	
ABS-equipped tractors pulling ABS-equipped trailers	1	X		X	X	X	X	X	X		7/7
	2										
	3										
	4										
ABS-equipped tractors pulling conventional braking trailers	1		X								1/8
	2	X			X			X	X		4/8
	3			X		X	X				3/8
	4										
Conventional brakes equipped tractors pulling ABS-equipped trailers	1										
	2						X				1/8
	3										
	4			X	X	X		X	X		5/8
Conventional brakes equipped tractors pulling conventional braking trailers	1										
	2		X	X		X					3/8
	3	X			X			X	X		4/8
	4						X				1/8

Question # 6 Any changes in driver braking habits due to ABS on following configurations?

		RESPONDENTS									TOTALS
		A	B	C	D	E	F	G	H	I	
ABS-equipped tractors pulling ABS-equipped trailers	Yes			X			X	X	X		4/7
	No	X			X	X					3/7
ABS-equipped tractors pulling conventional braking trailers	Yes			X			X		X		3/8
	No	X	X		X	X				X	5/8
Conventional brakes equipped tractors pulling ABS-equipped trailers	Yes			X							¼
	No				X	X			X		¾
Conventional brakes equipped tractors pulling conventional braking trailers	Yes			X							1/7
	No	X	X		X	X	X		X		6/7

Question # 7 Has ABS improved vehicle braking characteristics for the following configurations?

		RESPONDENTS									TOTALS
		A	B	C	D	E	F	G	H	I	
ABS-equipped tractors pulling ABS-equipped trailers											
Improved Braking	Yes	X		X	X	X			X		5/5
	No										
Improved Vehicle Stability	Yes	X		X	X	X		X	X		6/6
	No										
ABS-equipped tractors pulling conventional braking trailers											
Improved Braking	Yes	X	X	X	X	X			X	X	7/8
	No						X				1/8
Improved Vehicle Stability	Yes	X	X		X		X		X	X	6/8
	No			X		X					2/8
Conventional brakes equipped tractors pulling ABS-equipped trailers											
Improved Braking	Yes			X	X	X			X		4/4
	No										
Improved Vehicle Stability	Yes				X				X		2/4
	No			X		X					2/4

BUSES:

Question # 5 Driver Braking System Preference based on Vehicle Configuration

		RESPONDENTS	
		J	K
Intercity:			
Conventional	With ABS		
	Without ABS		
	Indifferent		X
Articulated	With ABS		
	Without ABS		
	Indifferent		
Transit:			
Conventional	With ABS		
	Without ABS		
	Indifferent		
Low-Floor	With ABS		
	Without ABS		
	Indifferent		
Articulated	With ABS		
	Without ABS		
	Indifferent		
Other	With ABS	X	
	Without ABS		
	Indifferent		

Question # 6 Any changes in driver braking habits due to ABS on following configurations?

		RESPONDENTS	
		J	K
Intercity:			
Conventional	Yes		
	No		X
Articulated	Yes		
	No		
Transit:			
Conventional	Yes		
	No		
Low-Floor	Yes		
	No		
Articulated	Yes		
	No		
Other	Yes	X	
	No		

Question # 7 Has ABS improved vehicle braking characteristics for the following configurations?

		RESPONDENTS	
		J	K
Intercity:			
Conventional with ABS:			
Improved Braking	Yes		
	No		
Improved Vehicle Stability	Yes		X
	No		
Articulated with ABS:			
Improved Braking	Yes		
	No		
Improved Vehicle Stability	Yes		
	No		
Transit:			
Conventional with ABS:			
Improved Braking	Yes		
	No		
Improved Vehicle Stability	Yes		
	No		
Low-Floor with ABS:			
Improved Braking	Yes		
	No		
Improved Vehicle Stability	Yes		
	No		
Articulated with ABS:			
Improved Braking	Yes		
	No		
Improved Vehicle Stability	Yes		
	No		
Other with ABS:			
Improved Braking	Yes	X	
	No		
Improved Vehicle Stability	Yes	X	
	No		

3.5 Operational Performance and Durability of ABS

The detailed information obtained from respondents is provided in Table 5. This information can be summarised as follows:

Trucks:

- ABS Operational Performance

  The distribution among respondents regarding ABS operational performance rating is the following:

High	30%
Satisfactory	42%
Low	13%
Inadequate	0%
No Opinion	15%

  When compared with the Phase I survey results we note a decrease in the High rating and an increase of the Low and No Opinion ratings. The Satisfactory rating is equivalent in both surveys.

- Durability of ABS

  The distribution among respondents regarding durability of ABS equipment is the following:

High	22%
Satisfactory	45%
Low	0%
Inadequate	0%
No Opinion	33%

  When compared to the Phase 1 survey results we note a decrease in the High rating.

Buses:

Unfortunately, meaningful ABS operational performance and durability results could not be derived from the small number of bus fleet respondents.

Table 5
OPERATIONAL PERFORMANCE AND DURABILITY OF ABS

TRUCKS:

Question # 14 ABS Operational Performance
(ABS performance based on fleet experience and driver reports over a six month period.)

		RESPONDENTS									TOTALS	TOTALS
		A	B	C	D	E	F	G	H	I		PHASE 1
14.1 Reliability of ABS to consistently perform as expected during vehicle operation	High	X			X	X					3/9	3/9
	Satisfactory		X				X	X	X	X	5/9	6/9
	Low											
	Inadequate											
	No opinion			X							1/9	
14.2 Reduction of vehicle stopping distance under severe brake application and slippery pavement conditions.	High	X						X			2/9	5/9
	Satisfactory		X		X	X	X		X	X	6/9	4/9
	Low											
	Inadequate											
	No opinion		X								1/9	
14.3 Increase in vehicle stability during brake application under slippery pavement conditions.	High	X				X		X	X		4/9	5/9
	Satisfactory		X		X		X			X	4/9	4/9
	Low											
	Inadequate											
	No opinion			X							1/9	
14.4 Adequacy of warning light in keeping driver aware of ABS operational status.	High	X								X	2/9	3/8
	Satisfactory		X			X			X		3/9	5/8
	Low				X			X			2/9	
	Inadequate											
	No opinion			X			X				2/9	
14.5 Reduction in premature tire wear by the prevention of tire flat spotting	High	X	X			X	X				4/9	6/8
	Satisfactory				X					X	2/9	1/8
	Low							X	X		2/9	1/8
	Inadequate											
	No opinion			X							1/9	
14.6 Reduction in brake system wear and maintenance	High					X					1/9	2/8
	Satisfactory	X			X		X				3/9	3/8
	Low							X	X	X	3/9	2/8
	Inadequate											
	No opinion		X	X							2/9	1/8
Please provide further comments if necessary.	Provided											
	Not provided	X	X	X	X	X	X	X	X	X		

Question # 15 Durability of ABS
(Based on trouble-free operation and/or maintenance requirements.)

	RESPONDENTS									TOTALS	TOTALS
	A	B	C	D	E	F	G	H	I		PHASE 1
High	X							X		2/9	3/9
Satisfactory				X		X	X		X	4/9	4/9
Low											
Inadequate											
No Opinion		X	X		X					3/9	2/9

BUSES:

Question # 14 ABS Operational Performance
(ABS performance based on fleet experience and driver reports over a 12 month period.)

		RESPONDENTS	
		J	K
14.1 Reliability of ABS to consistently perform as expected during vehicle operation	High Satisfactory Low Inadequate No opinion	X	X
14.2 Reduction of vehicle stopping distance under severe brake application and slippery pavement conditions.	High Satisfactory Low Inadequate No opinion	X	X
14.3 Increase in vehicle stability during brake application under slippery pavement conditions.	High Satisfactory Low Inadequate No opinion	X	X
14.4 Adequacy of warning light in keeping driver aware of ABS operational status.	High Satisfactory Low Inadequate No opinion	X	X
14.5 Reduction in premature tire wear by the prevention of tire flat spotting.	High Satisfactory Low Inadequate No opinion	X	X
14.6 Reduction in brake system wear and maintenance.	High Satisfactory Low Inadequate No opinion	X	X
Please provide further comments if necessary.	Provided Not provided	X	X

Question # 15 Durability of ABS
(Based on trouble-free operation and/or maintenance requirements.)

	RESPONDENTS	
	J	K
High		X
Satisfactory	X	
Low		
Inadequate		
No Opinion		

3.6 Accident Reduction/Adverse Effect of ABS

The detailed information obtained from respondents is provided in Table 6. This information can be summarised as follows:

Trucks:

- Accident Rate Reduction

  When asked to rate the performance of ABS with respect to its potential for accident rate reduction, the following answers were obtained:

  - 2/9 respondents rated this potential as HIGH while one respondent commented that an ABS system lowers the likelihood of a jack-knife.
  - 3/9 expressed a rating of MODERATE.
  - 2/9 expressed a rating of LOW.
  - 2/9 had NO OPINION.

  These results are similar to those found in the Phase 1 survey.

- Accident Severity Reduction

  When asked to rate the performance of ABS with respect to their potential for accident severity reduction, the following answers were obtained:

  - 3/9 respondents rated this potential as HIGH.
  - 1/9 expressed a rating of MODERATE.
  - 1/9 expressed a rating of LOW.
  - 1/9 expressed a rating of NOT SIGNIFICANT.
  - 3/9 had NO OPINION.

  These results are similar to those found in the Phase 1 survey.

- Potential Adverse Effect

  Three respondents indicated that, in their opinion, ABS could have an adverse effect on unpaved roads, in situations requiring a sudden stop, and when the driver depends on it too much and gains a false sense of security.

  One out of eight fleets has ABS-equipped with turn-off switches allowing the drivers to disable the systems if they so desire.

  Again, these results are similar to those found in the Phase 1 survey.

Buses:

- Accident Rate Reduction

  When asked to rate the performance of ABS with respect to its potential for accident rate reduction, the following answers were obtained:

  - 1/2 expressed a rating of MODERATE.
  - 1/2 had NO OPINION.

  When asked to rate the performance of ABS with respect to their potential for accident severity reduction, both respondents replied with a rating of NO OPINION.

- Potential Adverse Effect

  Of the two respondents, only one replied that ABS does not have an adverse effect of reducing safety.

  Neither respondents' ABS is equipped with turn-off switches.

Table 6
ACCIDENT REDUCTION/ADVERSE EFFECT OF ABS

TRUCKS:

Question # 11 Accident Rate and Severity Reduction

	RESPONDENTS									TOTALS	TOTALS PHASE 1
	A	B	C	D	E	F	G	H	I		
Accident Rate Reduction											
High	X	X								2/9	3/9
Moderate					X			X	X	3/9	1/9
Low				X			X			2/9	
Not significant											1/9
No opinion			X			X				2/9	4/9
Accident Severity Reduction											
High	X	X							X	3/9	3/9
Moderate								X		1/9	1/9
Low							X			1/9	
Not significant				X						1/9	1/9
No opinion			X		X	X				3/9	4/9
Give examples, if any, of situations where ABS caused an accident to be avoided or reduced its severity — Provided											
Not provided	X	X	X	X	X	X	X	X	X		

Question # 12 Potential Adverse Effect

		RESPONDENTS									TOTALS	TOTALS PHASE 1
		A	B	C	D	E	F	G	H	I		
12.1 Please indicate if there were situations or conditions in which ABS may have had the reverse effect of reducing safety	Yes		X		X				X		3/8	2/8
	No	X				X	X	X		X	5/8	6/8
If 'Yes' please provide details	Provided		X		X				X			
	Not provided											
12.2 Please indicate if your fleet's ABS are equipped with turn-off switches	Yes									X	1/8	
	No	X	X		X	X	X	X	X		7/8	9/9
If 'Yes', were there situations or conditions in which they were used by drivers?	Yes											
	No											
If 'Yes', please provide details	Provided									X		
	Not provided											

(B) Lower braking ability on unpaved surfaces.

(D) Drivers can have a false sense of security.

(H) Vehicles making sudden stops.

BUSES:

Question # 11 Accident Rate and Severity Reduction

		RESPONDENTS	
		J	K
Accident Rate Reduction			
High			
Moderate		X	
Low			
Not significant			
No opinion			X
Accident Severity Reduction			
High			
Moderate			
Low			
Not significant			
No opinion		X	X
Give examples, if any, of situations where ABS caused an accident to be avoided or reduced its severity	Provided		
	Not provided	X	X

Question # 12 Potential Adverse Effect

			RESPONDENTS	
			J	K
12.1	Please indicate if there were situations or conditions in which ABS may have had the reverse effect of reducing safety	Yes		
		No	X	
	If "Yes" please provide details	Provided		
		Not provided		
12.2	Please indicate if your fleet's ABS are equipped with turn-off switches	Yes		
		No	X	X
	If "Yes", were there situations or conditions in which they were used by drivers?	Yes		
		No		
	If "Yes", please provide details	Provided		
		Not provided		

3.7 Availability of ABS Parts, Service and Technical Support

The detailed information obtained from respondents is provided in Table 7. This information can be summarised as follows:

Trucks:

The responses obtained on this aspect of ABS operation ranged from EXCELLENT to POOR. However, most of the respondents rated this element as EXCELLENT or GOOD (4 or 6 out of 8). Analysis of the responses about the availability of adequately trained maintenance personnel and specialised shops revealed, however, that the lower ratings were generally from respondents that said that specialised shops were not available in their area.

In comparison with the Phase 1 survey, there is a perception of an overall improvement by the ABS manufacturers to increase the availability of parts, service and technical support.

Buses:

The response obtained ranged from GOOD to EXCELLENT. Both respondents rated technical support as EXCELLENT. However, respondent K rated the availability of adequately trained maintenance personnel and specialised maintenance shops as POOR despite the fact that the firm is located in a major centre.

Table 7
AVAILABILITY OF ABS PARTS, SERVICE AND TECHNICAL SUPPORT

TRUCKS:

Question # 17 Availability of ABS Parts, Service and Technical Support

		RESPONDENTS									TOTALS	TOTALS
		A	B	C	D	E	F	G	H	I		PHASE 1
17 1 Please rate, on the basis of global fleet experience with ABS during the last six months, the availability from ABS manufacturers and distributors of the following												
Replacement parts	Excellent						X				1/8	1/9
	Good	X							X	X	3/8	4/9
	Poor				X	X					2/8	2/9
	Very poor											1/9
	No opinion		X								1/8	1/9
Specialised maintenance equipment	Excellent						X	X			2/8	1/9
	Good	X			X				X	X	4/8	5/9
	Poor					X					1/8	1/9
	Very poor											1/9
	No opinion		X								1/8	1/9
Maintenance service and assistance	Excellent						X	X			2/8	1/9
	Good	X			X				X	X	4/8	4/9
	Poor										1/8	2/9
	Very poor					X					1/8	1/9
	No opinion		X								1/8	1/9
Technical support	Excellent						X	X			2/8	1/9
	Good	X			X				X	X	4/8	4/9
	Poor					X					1/8	2/9
	Very poor											1/9
	No opinion		X								1/8	1/9
Training programs for mechanics	Excellent						X	X			2/8	1/9
	Good	X			X				X	X	4/8	4/9
	Poor											2/9
	Very poor					X					1/8	1/9
	No opinion		X								1/8	1/9
17 2 Please rate the availability in your area(s) of operation of the following												
Adequately trained maintenance personnel	Excellent						X				1/8	1/9
	Good				X			X	X		3/8	4/9
	Poor	X				X					2/8	2/9
	Very poor											1/9
	No opinion		X								1/8	1/9
Specialised maintenance shops	Excellent						X				1/8	
	Good				X						1/8	1/9
	Poor	X							X		2/8	3/9
	Very poor					X					1/8	3/9
	No opinion		X								1/8	2/9
Please provide further comments	Provided											
	Not provided	X	X		X	X	X	X	X	X		

BUSES:

Question # 17 Availability of ABS Parts, Service and Technical Support

		RESPONDENTS	
		J	K
17.1 Please rate, on the basis of global fleet experience with ABS during the last six months, the availability from ABS manufacturers and distributors of the following			
Replacement parts	Excellent		
	Good	X	X
	Poor		
	Very poor		
	No opinion		
Specialised maintenance equipment	Excellent		
	Good	X	
	Poor		
	Very poor		
	No opinion		X
Maintenance service and assistance	Excellent		
	Good	X	
	Poor		
	Very poor		
	No opinion		X
Technical support	Excellent	X	X
	Good		
	Poor		
	Very poor		
	No opinion		
Training programs for mechanics	Excellent		X
	Good	X	
	Poor		
	Very poor		
	No opinion		
17.2 Please rate the availability in your area(s) of operation of the following			
Adequately trained maintenance personnel	Excellent		
	Good	X	
	Poor		X
	Very poor		
	No opinion		
Specialised maintenance shops	Excellent		
	Good	X	
	Poor		X
	Very poor		
	No opinion		
Please provide further comments	Provided		
	Not provided	X	X

3.8 Vehicle and ABS Maintenance

The detailed information obtained from respondents is provided in Tables 8 and 9. This information can be summarised as follows:

Trucks:

- Vehicle Maintenance and Where Performed

  Responses for this element are very similar to the responses obtained in the Phase 1 survey. The findings indicate that a majority of the work on vehicle, braking system and ABS maintenance is carried out in the fleet's own facilities. They also indicate that the same persons generally perform conventional braking system and ABS maintenance.

  In comparison with the Phase 1 survey we note a definite increase in ABS maintenance performed by speciality shops. In addition, a fewer number of respondents rely on contract maintenance. However the overall percentage of work performed by these contractors is relatively unchanged.

- ABS Maintenance Complexity

  With respect to the maintenance complexity of ABS-equipped vehicles, more than half of the fleet mangers considered it to be simple. Vehicle maintainers, on the other hand, rated the maintenance complexity as simple to complex. In comparison to Phase 1 we note a definite change in fleet manager and vehicle maintainer ratings from relatively complex to simple. This change may be attributable to the increased knowledge gained over the period between the two surveys.

- ABS Maintenance Policy

  With regards to ABS maintenance policy, the majority of respondents (5/9) indicated that a defective ABS is repaired prior to the unit's next dispatch while two other fleets correct the situation within one day. The remaining two respondents correct the situation within one week. The findings indicate no significant difference with the results of the previous survey.

- ABS Maintenance Requirements

  Only one respondent provided records of the maintenance requirements of their ABS. This fleet, operating a total of 60 ABS-equipped units, reported 65 maintenance requirements over a six-month period, 50 of which related to speed sensors and 15 related to cables and connectors. In comparison with the Phase 1 report we note a definite increase in the maintenance activities related to this

component of the ABS system. However, no proper analysis can be provided since the findings are based on the response provided by this sole respondent.

Other respondents indicated failures related to the Electronic Control Unit (ECU), speed sensors, pressure modulating valves, cables and connectors and warning lights. However, a comparative analysis with the findings of the previous Phase was not performed since the respondent provided no precise detail as to the number of interventions.

Buses:

- Vehicle Maintenance and Where Performed

  Here again the findings indicate that almost all the work relating to vehicle, breaking systems and ABS maintenance is performed in the fleet owners' facilities. They also indicate that the same persons generally perform braking system and ABS maintenance.

- ABS Maintenance Complexity

  Contrary to the findings relating to truck fleets, bus maintainers rank ABS maintenance as relatively simple to very complex. Conversely, the findings indicate that bus fleet managers regard ABS maintenance as relatively simple. However, this finding is based on the answers provided by two respondents only and therefore it should not be considered representative of the industry.

- ABS Maintenance Policy

  Respondents J and K indicated that defective ABS systems are repaired prior to the next dispatch and within one week respectively.

- ABS Maintenance Requirements

  Unfortunately, respondents provided insufficient data to conduct a proper analysis.

Table 8
VEHICLE AND ABS MAINTENANCE

TRUCKS:

Question # 10 **Vehicle Maintenance and Where Performed**
(As percentages of total fleet maintenance expenditures)

	RESPONDENTS									AVERAGE	AVERAGE PHASE 1
	A	B	C	D	E	F	G	H	I		
10.1 Vehicle Maintenance											
Performed in own facilities		100%	5%	80%	60%	20%	100%	90%	100%	69%	70%
Performed in specialised shops				10%				10%		2%	5%
Performed by maintenance contractors			95%	10%	40%	80%				28%	25%
10.2 Braking Systems Maintenance											
Performed in own facilities		100%	5%	80%	60%	20%	100%	95%	100%	70%	69%
Performed in specialised shops								5%		1%	3%
Performed by maintenance contractors			95%	20%	40%	80%				29%	29%
10.3 ABS Maintenance											
Performed in own facilities		100%	5%	50%	60%		100%	95%	100%	64%	68%
Performed in specialised shops			95%	50%				5%		19%	14%
Performed by maintenance contractors					40%	100%				17%	18%
10.4 Are ABS maintenance and general braking systems maintenance performed by the same persons?											
Yes		X	X	X	X	X	X	X	X	8/8	8/9
No											1/9

Question # 18 **ABS Maintenance Complexity**

		RESPONDENTS									TOTALS	TOTALS PHASE 1
		A	B	C	D	E	F	G	H	I		
by Fleet Management	Very complex											
	Relatively complex			X							1/8	3/10
	Relatively simple				X					X	2/8	3/10
	Simple	X				X	X	X			4/8	2/10
	No opinion		X								1/8	2/10
by Vehicle Maintainers	Very complex											
	Relatively complex			X	X						2/7	4/10
	Relatively simple					X				X	2/7	3/10
	Simple	X					X				2/7	2/10
	No opinion		X								1/7	1/10
Please provide further comments												
	Provided											
	Not Provided	X	X	X	X	X	X	X		X		

Question # 13 **ABS Maintenance Policy**
(When a defective ABS was to be corrected)

		RESPONDENTS									TOTALS	TOTALS PHASE 1
		A	B	C	D	E	F	G	H	I		
Prior to the unit's next dispatch		X	X		X	X				X	5/9	6/10
Within a period of	1 day				X		X				2/9	2/10
	1 week							X	X		2/9	
	1 month											
At the unit's next scheduled maintenance								X			1/9	2/10

BUSES:

Question # 10 **Vehicle Maintenance and Where Performed**
(As percentages of total fleet maintenance expenditures)

	RESPONDENTS	
	J	K
10 1 Vehicle Maintenance		
Performed in own facilities	100%	97%
Performed in specialised shops		3%
Performed by maintenance contractors		
10 2 Braking Systems Maintenance	98%	100%
Performed in own facilities	2%	
Performed in specialised shops		
Performed by maintenance contractors		
10 3 ABS Maintenance		
Performed in own facilities	95%	100%
Performed in specialised shops	5%	
Performed by maintenance contractors		
10 4 Are ABS maintenance and general braking systems maintenance performed by the same persons?		
Yes	X	X
No		

Question # 18 **ABS Maintenance Complexity**

		RESPONDENTS	
		J	K
by Fleet Management	Very complex		
	Relatively complex		
	Relatively simple		X
	Simple		
	No opinion	X	
by Vehicle Maintainers	Very complex		X
	Relatively complex	X	
	Relatively simple		
	Simple		
	No opinion		
Please provide further comments			
	Provided		
	Not Provided	X	X

Question # 13 **ABS Maintenance Policy**
(When a defective ABS was to be corrected)

		RESPONDENTS	
		J	K
Prior to the unit's next dispatch		X	
Within a period of	1 day		
	1 week		X
	1 month		
At the unit's next scheduled maintenance			

Table 9
ABS MAINTENANCE REQUIREMENTS

TRUCKS:

Question # 16 ABS Maintenance Requirements

Component / Source / Cause of failure / Nature of Maintenance	RESPONDENTS A	B	C	D	E	F	G	H	I	TOTALS	TOTALS PHASE 1
Electronic Control Unit											**3**
Equipment failure											3
Adjustment									X		
Repair											2
Replacement							X				1
External damage											
Adjustment											
Repair											
Replacement							X				
Speed Sensors				**50**						**50**	**9**
Equipment failure				40						40	7
Adjustment											
Repair								X			1
Replacement				40		X			X	40	6
External damage				10						10	2
Adjustment				10						10	
Repair											
Replacement							X				2
Pressure Modulating Valves											**2**
Equipment failure											2
Adjustment											
Repair											
Replacement						X					2
External damage											
Adjustment											
Repair											
Replacement											
Cables & Connectors				**15**						**15**	**13**
Equipment failure				10						10	1
Adjustment											
Repair						X	X	X			1
Replacement				10						10	
External damage				5						5	12
Adjustment											
Repair				2						2	5
Replacement				3				X		3	7
Warning Light											**5**
Equipment failure											5
Adjustment											
Repair											1
Replacement											4
External damage											
Adjustment											
Repair											
Replacement							X				
Please provide further comments: Provided											
Not provided				X		X	X	X	X		

Note: Whenever one of these types of equipment has either failed or been damaged they have been replaced. Most companies surveyed over the phone have experienced most types and gave yes and no answers.

BUSES:

Question # 16 ABS Maintenance Requirements

Component	Source / Cause of failure	Nature of Maintenance	RESPONDENTS J	RESPONDENTS K
Electronic Control Unit				
	Equipment failure			
		Adjustment		
		Repair		
		Replacement		
	External damage			
		Adjustment		
		Repair		
		Replacement		
Speed Sensors				
	Equipment failure			
		Adjustment		
		Repair		
		Replacement		X
	External damage			
		Adjustment		
		Repair		
		Replacement		
Pressure Modulating Valves				
	Equipment failure		X	
		Adjustment		
		Repair		
		Replacement		
	External damage			
		Adjustment		
		Repair		
		Replacement		
Cables & Connectors				
	Equipment failure			
		Adjustment		
		Repair		X
		Replacement		X
	External damage			
		Adjustment		
		Repair		
		Replacement		
Warning Light				
	Equipment failure			
		Adjustment		
		Repair		
		Replacement		
	External damage			
		Adjustment		
		Repair		
		Replacement		
Please provide further comments		Provided		X
		Not provided	X	

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3.9 Cost Impact of ABS

The detailed information obtained from respondents is provided in Table 10. This information can be summarised as follows:

Trucks:

- Impact of ABS on Vehicle Purchase Price

  Approximately 55% of the respondents estimate that the impact of ABS on vehicle purchase prices, expressed as a percentage of the additional ABS cost over the purchase price of an identical vehicle without ABS, is in the 2% to 5% range. Another 33% of respondents estimate the impact on vehicle purchase price in the 1% to 2% range. The lower values in this range are likely to apply to motorised units (trucks and tractors) which have a higher purchase price while the higher values apply to the less expensive trailers. In comparison with the Phase 1 survey we find no significant difference except for a noticeable increase of respondents in the 1% to 2% range. This could be indicative of overall price reductions as ABS technology matures and becomes more readily available.

- Impact of ABS on Vehicle Maintenance Costs

  The impact of ABS on vehicle maintenance costs, as a percentage of additional maintenance costs associated with ABS over the total maintenance costs of identical vehicles without ABS, was estimated to be inferior to 5% by five out of seven respondents with two estimating a value inferior to 1% and two respondents estimating a value between 1% and 2%. In comparison with the Phase 1 survey we note a reduction in the number of respondents who estimate the impact of ABS on vehicle maintenance costs between the 2% to 5% range. As mentioned previously, a better knowledge of ABS systems and therefore improved maintenance practices may have contributed to this improvement.

- Impact of ABS on Total Vehicle Operating Costs

  The impact of ABS on total vehicle operating costs, as a percentage of additional operating costs of the vehicle generated by ABS over the total operating costs of identical vehicles without ABS, was estimated at:

  - Less than 0.5% by 2/6 respondents
  - Between 1% and 2% by 3/6 respondents
  - Over 5% by one respondent

  There is no significant difference when compared to the findings of the Phase 1 survey therefore the assumption is that that the impact of ABS on total vehicle operating costs has remained relatively constant.

Buses:

- Impact of ABS on Vehicle Purchase Price

  Unfortunately, the respondents did not reply to this question.

- Impact of ABS on Vehicle Maintenance Costs

  The impact of ABS on vehicle maintenance costs, as a percentage of additional maintenance costs associated with ABS over the total maintenance costs of identical vehicles without ABS, was estimated to be less than 1% by respondent K and between 2% and 5% for respondent J.

- Impact of ABS on Total Vehicle Operating Costs

  Respondent J indicated that the impact of ABS on total vehicle operating costs was between 2% and 5%. Unfortunately, respondent K provided no answer.

Table 10
COST IMPACT OF ABS

TRUCKS:

Question # 19 Impact of ABS on Vehicle Purchase Prices

	RESPONDENTS									TOTALS	TOTALS
	A	B	C	D	E	F	G	H	I		PHASE 1
Less than 1%	X									1/9	2/10
1 % to 2%				X		X			X	3/9	
2% to 5%		X	X		X		X	X		5/9	6/10
5% to 10%											1/10
More than 10%											1/10

Question # 20 Impact of ABS on Vehicle Maintenance Costs

	RESPONDENTS									TOTALS	TOTALS
	A	B	C	D	E	F	G	H	I		PHASE 1
Less than 1%			X				X			2/7	3/8
1 % to 2%						X		X		2/7	1/8
2% to 5%					X					1/7	3/8
More than 5%									X	1/7	1/8
Please provide further comments — Provided				X						1/7	
Please provide further comments — Not provided			X		X	X	X	X	X	6/7	

(D) Unknown at this time

Question # 21 Impact of ABS on Total Vehicle Operating Costs

	RESPONDENTS									TOTALS	TOTALS
	A	B	C	D	E	F	G	H	I		PHASE 1
Less than 0.5%							X	X		2/6	3/6
0.5 % to 1%											
1% to 2%			X		X	X				3/6	2/6
2% to 5%											
More than 5%									X	1/6	1/6
Please provide further comments — Provided			X	X						2/7	
Please provide further comments — Not provided					X	X	X	X	X	5/7	

(D) Unknown at this time

BUSES:

Question # 19 Impact of ABS on Vehicle Purchase Prices

Unknown at the time of survey for respondents J and K

Question # 20 Impact of ABS on Vehicle Maintenance Costs

		RESPONDENTS	
		J	K
Less than 1%			X
1 % to 2%			
2% to 5%		X	
More than 5%			
Please provide further comments	Provided	X	
	Not provided		X

Question # 21 Impact of ABS on Total Vehicle Operating Cost

		RESPONDENTS	
		J	K
Less than 0.5%			
0.5 % to 1%			
1% to 2%			
2% to 5%		X	
More than 5%			
Please provide further comments	Provided	X	
	Not provided		X

(K) Unknown at this time

3.10 Further Comments and Information

None of the respondents to this survey provided further comments and information relative to their experience with ABS. However, upon further investigation one bus fleet respondent mentioned that ABS-equipped vehicles are especially well suited for novice drivers.

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4.0 CONCLUSIONS AND RECOMMENDATIONS

This last chapter contains the conclusions derived from, and the recommendations supported by, the results of this survey of the experience of Canadian motor carriers with respect to the performance, durability and maintainability of Antilock Braking Systems installed on heavy vehicles, as well as of the impact of these systems on vehicle operating costs.

4.1 Conclusions

The results of this survey, as they appear in the detailed tables and summaries provided in Section 3.0, support the following conclusions with respect to the experience of fleet operators with ABS installed on heavy vehicles.

- Fleet operators appear to have a generally positive perception of ABS as useful, reliable, durable and relatively trouble-free equipment that is more and more frequently installed on new vehicles and is becoming a trucking industry standard.

- Respondents from the previous survey have increased their fleet of ABS-equipped vehicles.

- A high proportion of heavy vehicle drivers is experienced with ABS-equipped vehicles.

- In terms of road safety, respondents to the survey acknowledge that ABS improves vehicle braking in emergency situations and increase vehicle stability during braking.

- A majority of respondents rated operational performance and durability of ABS equipment as satisfactory.

- Fleet managers and maintainers rated the ABS systems less complex than in the previous survey.

- The availability, from ABS manufacturers or through specialised maintenance shops, of parts, service and technical support is perceived by most fleet operators as good to excellent.

- Survey respondents estimated the cost impacts of ABS as follows:

    - Increase in unit purchase prices: 2-5%.
    - Increase in unit maintenance costs: 0-1% and 1-2%, each range reported by an equal number of respondents.
    - Increase in total vehicle oper ating costs: approximate average of 1%.

4.2 Recommendations

The survey results and the above conclusions justify the following recommendations with respect to furthering knowledge of in-service performance and impact of ABS on the operations of truck and bus fleets.

Many of the impacts of ABS technology on vehicle fleets can only be evaluated over a long period of time from a representative sample of truck and bus fleets. Therefore, periodic surveys are necessary. However, our experience indicated that a fair number of fleet operators contacted had difficulty in completing the detailed questionnaires because of the perceived complexity and time constraints.

To facilitate the collection of data TDC should work with selected fleet operators in order to ensure that consistent and reliable information is collected. This information could be exchanged through electronic means such as the Internet or through a Web site dedicated to this purpose.

APPENDIX A

SURVEY QUESTIONNAIRES

Transport Canada
Transportation Development Centre

FLEET SURVEY OF HEAVY VEHICLE ABS SYSTEMS OPERATION : TRUCKS

Questionnaire - November 1997

Covering six-month period from JANUARY 1997 to JUNE 1997

GROUPE CARTIER LTÉE
November 1997

Survey Objectives

The objective of this survey is to obtain feedback from Canadian motor carriers operating heavy vehicles with installed ABS systems in order to determine their experience with ABS technology as it relates to vehicle braking performance and accident rates as well as ABS system performance, durability, maintainability and impact on vehicle operating cost.

The survey of participating fleets may be complemented by telephone follow-ups and/or on-site visits as required to establish statistically valid results from a representative cross section of ABS system users.

Instructions

1 - Respondents are asked to answer all sections of the questionnaire providing information that best reflect their fleet's characteristics and experience with ABS technology during the six-month period between **January and June 1997**.

2 - Information obtained from various fleets will be aggregated and averaged to provide an industry wide indication of experience with ABS systems installed on heavy vehicles. Consequently, where respondants are asked to provide numbers and/or percentages, high accuracy is not essential. Approximate, but representative, answers are sufficient and obviously more useful than no answer at all.

3 - Requests for information or queries on the survey and/or this questionnaire should be directed to the Consultant mandated by the Transportation Development Centre:

Groupe Cartier ltée
2045 Stanley Street
11th Floor
Montreal, Quebec
H3A 2V4
Telephone: (514) 499-4500 Fax: (514) 499-4515

Attention: Mr Matthew Juckes, Eng.
Mr Marc Girardin, Eng.

4 - Questionnaires should be returned **before February 1st, 1998**, either by mail or fax, to the address or number and to the attention of the persons indicated above.

1.0 Company and Contact Names

1.1 Name and Address of Company

_____

_____

_____

_____

1.2 Contact for Purposes of this Survey

Name: _____

Title: _____

Telephone: _____

Fax: _____

2.0 Fleet Statistics

2.1 Number of Heavy Vehicles in Fleet

	Conventional Braking	ABS Equipped
Heavy Trucks:	_____	_____
Tractors:	_____	_____
Semi-Trailers (excluding A and B trains):	_____	_____
A-Train trailers:	_____	_____
B-Train trailers:	_____	_____
Other:_____	_____	_____
Totals	_____	_____

2.2 Tractor/Trailer Combinations

Indicate which tractor/trailer combinations your company operates on a % of trips basis, approximately.

	%
ABS-equipped tractors pulling ABS-equipped trailers :	_____
ABS-equipped tractors pulling conventional braking trailers :	_____
Conventional brakes equipped tractors pulling ABS-equipped trailers :	_____
Conventional brakes equipped tractors pulling conventional braking trailers :	_____

3.0 Number of Heavy Vehicle Drivers with ABS experience

No experience with ABS: _____

Less than 1 year of experience with ABS: _____

1 to 2 years of experience with ABS: _____

More than 2 years of experience with ABS: _____

Total _____

4.0 Any Driver ABS Training Program or courses given, and who gave training.

	Given by company	Given by ABS	Given by Vehicle	Given by	Duration
Theory:	☐	☐	☐	☐	_____ hrs
Practice:	☐	☐	☐	☐	_____ hrs

5.0 Ranking of Vehicle Combinations according to Driver preference.
(i.e., 1 most preferred, 4 least preferred)

ABS-equipped tractors pulling ABS-equipped trailers : ☐
ABS-equipped tractors pulling conventional braking trailers : ☐
Conventional brakes equipped tractors pulling ABS-equipped trailers : ☐
Conventional brakes equipped tractors pulling conventional braking trailers : ☐

Reason for preference

_____
_____
_____

6.0 Any changes in driver braking habits due to ABS on following configurations :

	Yes	No
ABS-equipped tractors pulling ABS-equipped trailers :	☐	☐
ABS-equipped tractors pulling conventional braking trailers :	☐	☐
Conventional brakes equipped tractors pulling ABS-equipped trailers :	☐	☐
Conventional brakes equipped tractors pulling conventional braking trailers :	☐	☐

Reason for any change

_____
_____
_____

7.0 Has ABS improved vehicle braking characteristics for the following configurations :

	Improved Braking		Improved Vehicle Stability	
	Yes	No	Yes	No
ABS-equipped tractors pulling ABS-equipped trailers :	☐	☐	☐	☐
ABS-equipped tractors pulling conventional braking trailers :	☐	☐	☐	☐
Conventional brakes equipped tractors pulling ABS-equipped trailers :	☐	☐	☐	☐

8.0 Description and Number of ABS Systems

Manufacturer	Model Number	Use of proportioning/ limiting valves (Yes/no)	Year	Number of Systems

9.0 Operations Characteristics

9.1 Distances Travelled

(Average distance travelled by a typical fleet vehicle in the 6-month period)

Conventional Braking Units: _____ km

ABS Equipped Units: _____ km

9.2 Types of Products Hauled

(As percentages of total distance travelled by all fleet vehicles)

	Conventional Braking	**ABS Equipped**
General:	_____ %	_____ %
Bulk Solids:	_____ %	_____ %
Bulk Liquids:	_____ %	_____ %
Other: _____	_____ %	_____ %
Other: _____	_____ %	_____ %
Totals	**100** %	**100** %

9.3 Types of Hauling Environment

(As percentages of total distance travelled by all fleet vehicles)

	Conventional Braking	**ABS Equipped**
Urban:	_____ %	_____ %
Suburban:	_____ %	_____ %
Intercity:	_____ %	_____ %
Other: _____	_____ %	_____ %
Totals	**100** %	**100** %

10.0 Vehicle Maintenance and Where Performed

(As percentages of total fleet maintenance expenditures)

10.1 Vehicle Maintenance

Performed in own facilities:	_____ %
Performed in specialised shops:	_____ %
Performed by maintenance Contractors:	_____ %
Total	**100** %

10.2 Braking Systems Maintenance

Performed in own facilities:	_____ %
Performed in specialised shops:	_____ %
Performed by maintenance Contractors:	_____ %
Total	**100** %

10.3 ABS Systems Maintenance

Performed in own facilities:	_____ %
Performed in specialised shops:	_____ %
Performed by maintenance Contractors:	_____ %
Total	**100** %

10.4 Are ABS systems maintenance and general braking systems maintenance performed by the same persons?

Yes ☐ No ☐

11.0 Accident Rate and Severity Reduction

Please provide your best estimate of the potential of ABS systems to reduce accident rate and severity.

Accident Rate Reduction		Accident Severity Reduction	
High	☐	High	☐
Moderate	☐	Moderate	☐
Low	☐	Low	☐
Not Significant	☐	Not Significant	☐
No Opinion	☐	No Opinion	☐

Give examples, if any, of situations where ABS contributed in the avoidance of an accident or in the reduction of its severity.

_____

_____

_____

12.0 Potential Adverse Effect

12.1 Please indicate if there were situations or conditions in which ABS may have had the reverse effect of reducing safety.

Yes ☐ No ☐

If "Yes", please provide details.

_____

_____

_____

12.2 Please indicate if your fleet's ABS systems are equipped with turn-off switches.

Yes ☐ No ☐

If "Yes", were there situations or conditions in which they were used by drivers?

Yes ☐ No ☐

If "Yes", please provide details.

_____

_____

_____

13.0 ABS Systems Maintenance Policy

If a unit's ABS system is defective, please indicate, on the basis of your fleet's policy and procedures, when the situation was to be corrected.

Prior to the unit's next dispatch ☐

Within a period of: 1 day ☐ 1 week ☐ 1 month ☐

At the unit's next scheduled maintenance ☐

14.0 ABS Systems Operational Performance

Please rate the following aspects of ABS systems performance based on your fleet's experience and driver reports during the last six months.

		High	Satisfactor	Low	Inadequate	No Opinion
14.1	Reliability of ABS systems to consistently perform as expected during vehicle operation.	☐	☐	☐	☐	☐
14.2	Reduction of vehicle stopping distance under severe brake application and slippery pavement conditions.	☐	☐	☐	☐	☐
14.3	Increase in vehicle stability during brake application under slippery pavement conditions.	☐	☐	☐	☐	☐
14.4	Adequacy of Warning Light in keeping driver aware of ABS system operational status.	☐	☐	☐	☐	☐
14.5	Reduction in premature tire wear by the prevention of tire "Flat Spotting".	☐	☐	☐	☐	☐
14.6	Reduction in brake system wear and maintenance.	☐	☐	☐	☐	☐

Please provide further comments if necessary.

_____
_____
_____
_____
_____
_____
_____
_____

15.0 Durability of ABS Systems

Please rate the durability of this equipment based on its trouble free operation and/or its maintenance requirements.

High ☐ Satisfactory ☐ Low ☐ Inadequate ☐

No Opinion ☐

16.0 ABS Systems Maintenance Requirements

Please indicate ABS maintenance requirements by writing in the appropriate boxes below the total numbers of maintenance activities performed on all ABS equipped fleet vehicles. You are asked to provide a breakdown of these activities by System Component, Cause of Failure and Nature of Repair.

Failed Component of ABS System	Numbe	Source / Cause of Component Failure	Numbe	Nature of Maintenance Activity	Numbe
ECU	☐	Equipment failure External damage	☐ ☐	Adjustment Repair Replacement	☐ ☐ ☐
Speed Sensors	☐	Equipment failure External damage	☐ ☐	Adjustment Repair Replacement	☐ ☐ ☐
Pressure Modulating Valves	☐	Equipment failure External damage	☐ ☐	Adjustment Repair Replacement	☐ ☐ ☐
Cables & Connectors	☐	Equipment failure External damage	☐ ☐	Adjustment Repair Replacement	☐ ☐ ☐
Warning Light	☐	Equipment failure External damage	☐ ☐	Adjustment Repair Replacement	☐ ☐ ☐

Please provide further comments if necessary.

17.0 Availability of ABS Parts, Service and Technical Support

	Excellent	Good	Poor	Very Poor	No
17.1 Please rate, on the basis of global fleet experience with ABS systems during the last six months, the availability from ABS systems manufacturers and distributors of the following:					
Replacement parts	☐	☐	☐	☐	☐
Specialized maintenance equipment	☐	☐	☐	☐	☐
Maintenance service and assistance	☐	☐	☐	☐	☐
Technical support	☐	☐	☐	☐	☐
Training programs for mechanics	☐	☐	☐	☐	☐
17.2 Please rate the availability in your area(s) of operation of the following:					
Adequately trained maintenance personnel	☐	☐	☐	☐	☐
Specialized maintenance shops	☐	☐	☐	☐	☐

Please provide further comments if necessary.

_____

_____

_____

_____

18.0 ABS Maintenance Complexity

Please indicate the perceived level of complexity of ABS system maintenance.

	by Fleet Management	by Vehicle Maintainers
Very complex	☐	☐
Relatively complex	☐	☐
Relatively simple	☐	☐
Simple	☐	☐
No opinion	☐	☐

Please provide further comments if necessary.

_____

_____

_____

_____

19.0 Impact of ABS Systems on Vehicle Purchase Prices

Please indicate, on the basis of your more recent purchases of vehicles, the impact of ABS systems on vehicle purchase prices. Indicate this as a percentage of additionnal ABS system cost over the purchase price of an identical vehicle without ABS. Use an average figure based on the types of units in your fleet.

Less than 1% ☐ 1 % to 2% ☐ 2% to 5% ☐

5% to 10% ☐ More than 10% ☐

20.0 Impact of ABS Systems on Vehicle Maintenance Costs

Please indicate the impact of ABS systems on vehicle maintenance costs. Indicate this as a percentage of additionnal maintenance costs associated with ABS systems over the total maintenance costs (excluding vehicle down-time) of identical vehicles without ABS. Use an average figure based on the type of units in your fleet.

Less than 1% ☐ 1 % to 2% ☐

2% to 5% ☐ More than 5% ☐

Please provide further comments if necessary.

_____

_____

_____

21.0 Impact of ABS Systems on Total Vehicle Operating Costs

Please indicate your best overall estimate of the impact of ABS systems on total vehicle operating costs. An average figure should be given that is representative of the types of units in your fleet. Indicate this as the percentage of additionnal operating costs of the vehicle generated by ABS systems over the total operating cost (including all fleet management and overhead as well as vehicle down-time) of identical vehicles without ABS.

Less than 0,5% ☐ 0,5 % to 1% ☐ 1% to 2% ☐

2% to 5% ☐ More than 5% ☐

Please provide further comments if necessary.

_____

_____

_____

22.0 Further Comments and Information on ABS Systems

Please use this page and, if necessary, additionnal pages to provide further comments and information on ABS Systems and issues you believe need to be further addressed, that you consider pertinent to this survey and its stated objectives.

Transport Canada
Transportation Development Centre

FLEET SURVEY OF HEAVY VEHICLE ABS SYSTEMS OPERATION : BUSES

Questionnaire - November 1997

Covering six-month period from JANUARY 1997 to JUNE 1997

GROUPE CARTIER LTÉE
November 1997

Survey Objectives

The objective of this survey is to obtain feedback from Canadian intercity and transit operators operating buses with installed ABS systems in order to determine their experience with ABS technology as it relates to vehicle braking performance and accident rates as well as ABS system performance, durability, maintainability and impact on vehicle operating cost.

The survey of participating operators may be complemented by telephone follow-ups and/or on-site visits as required to establish statistically valid results from a representative cross section of ABS system users.

Instructions

1 - Respondents are asked to answer all sections of the questionnaire providing information that best reflect their fleet's characteristics and experience with ABS technology during the six-month period between **January and June 1997**.

2 - Information obtained from various operators will be aggregated and averaged to provide an industry wide indication of experience with ABS systems installed on intercity and transit buses. Consequently, where respondants are asked to provide numbers and/or percentages, high accuracy is not essential. Approximate, but representative, answers are sufficient and obviously more useful than no answer at all.

3 - Requests for information or queries on the survey and/or this questionnaire should be directed to the Consultant mandated by the Transportation Development Centre:

Groupe Cartier ltée
2045 Stanley Street
11th Floor
Montreal, Quebec
H3A 2V4
Telephone: (514) 499-4500 Fax: (514) 499-4515

Attention: Mr Matthew Juckes, Eng.
Mr Marc Girardin, Eng.

4 - Questionnaires should be returned **before February 1st, 1998**, either by mail or fax, to the address or number and to the attention of the persons indicated above.

1.0 Company and Contact Names

1.1 Name and Address of Company

_____

_____

_____

_____

1.2 Contact for Purposes of this Survey

Name: _____

Title: _____

Telephone: _____

Fax: _____

2.0 Fleet Statistics

2.1 Number of Buses in Fleet

	Conventional Braking	ABS Equipped
Intercity:		
Conventional	_____	_____
Articulated	_____	_____
Transit:		_____
Conventional	_____	_____
Low-Floor	_____	_____
Articulated	_____	_____
Other:_____	_____	_____
Totals	_____	_____

3.0 Number of Bus Drivers with ABS experience

No experience with ABS:	_____
Less than 1 year of experience with ABS:	_____
1 to 2 years of experience with ABS:	_____
More than 2 years of experience with ABS:	_____
Total	_____

4.0 Any Driver ABS Training Program or courses given, and who gave training.

	Given by company	Given by ABS	Given by Bus Manufacturer	Given by	Duration
Theory:	☐	☐	☐	☐	_____ hrs
Practice:	☐	☐	☐	☐	_____ hrs

5.0 Driver Braking System Preference on following Configurations

	With ABS	Without	Indifferent
Intercity:			
Conventional	☐	☐	☐
Articulated	☐	☐	☐
Transit:			
Conventional	☐	☐	☐
Low-Floor	☐	☐	☐
Articulated	☐	☐	☐
Other: _____	☐	☐	☐

6.0 Any changes in driver braking habits due to ABS on following configurations :

	Yes	No
Intercity:		
Conventional with ABS	☐	☐
Articulated with ABS	☐	☐
Transit:		
Conventional with ABS	☐	☐
Low-Floor with ABS	☐	☐
Articulated with ABS	☐	☐
Other with ABS : _____	☐	☐

7.0 Has ABS improved vehicle braking characteristics for the following configurations :

	Improved Braking		Improved Vehicle Stability	
	Yes	No	Yes	No
Intercity:				
Conventional with ABS	☐	☐	☐	☐
Articulated with ABS	☐	☐	☐	☐
Transit:				
Conventional with ABS	☐	☐	☐	☐
Low-Floor with ABS	☐	☐	☐	☐
Articulated with ABS	☐	☐	☐	☐
Other with ABS : _____	☐	☐	☐	☐

8.0 Description and Number of ABS Systems

Manufacturer	Model Number	Use of proportioning/ limiting valves (Yes/no)	Year	Number of Systems

9.0 Operations Characteristics

9.1 Distances Travelled
(Average distance travelled by a typical bus in the 6-month period)

Conventional Braking Units: _____ km
ABS Equipped Units: _____ km

9.2 Types of Operation
(As percentages of total distance travelled by all buses)

	Conventional Braking	ABS Equipped
Urban Transit:	_____ %	_____ %
Suburban Transit:	_____ %	_____ %
Intercity:	_____ %	_____ %
Charter:	_____ %	_____ %
Other: _____	_____ %	_____ %
Totals	**100 %**	**100 %**

9.3 Types of Transportation Environment
(As percentages of total distance travelled by all buses)

	Conventional Braking	ABS Equipped
Urban:	_____ %	_____ %
Suburban:	_____ %	_____ %
Intercity:	_____ %	_____ %
Other:_____	_____ %	_____ %
Totals	**100 %**	**100 %**

10.0 Vehicle Maintenance and Where Performed
(As percentages of total fleet maintenance expenditures)

10.1 Vehicle Maintenance

Performed in own facilities:	_____ %
Performed in specialised shops:	_____ %
Performed by maintenance Contractors:	_____ %
Total	**100 %**

10.2 Braking Systems Maintenance

Performed in own facilities:	_____ %
Performed in specialised shops:	_____ %
Performed by maintenance Contractors:	_____ %
Total	**100 %**

10.3 ABS Systems Maintenance

Performed in own facilities:	_____ %
Performed in specialised shops:	_____ %
Performed by maintenance Contractors:	_____ %
Total	**100 %**

10.4 Are ABS systems maintenance and general braking systems maintenance performed by the same persons?

Yes ☐ No ☐

11.0 Accident Rate and Severity Reduction

Please provide your best estimate of the potential of ABS systems to reduce accident rate and severity.

Accident Rate Reduction		Accident Severity Reduction	
High	☐	High	☐
Moderate	☐	Moderate	☐
Low	☐	Low	☐
Not Significant	☐	Not Significant	☐
No Opinion	☐	No Opinion	☐

Give examples, if any, of situations where ABS contributed in the avoidance of an accident or in the reduction of its severity.

_____

_____

_____

12.0 Potential Adverse Effect

12.1 Please indicate if there were situations or conditions in which ABS may have had the reverse effect of reducing safety.

Yes ☐ No ☐

If "Yes", please provide details.

_____

_____

_____

12.2 Please indicate if your fleet's ABS systems are equipped with turn-off switches.

Yes ☐ No ☐

If "Yes", were there situations or conditions in which they were used by drivers?

Yes ☐ No ☐

If "Yes", please provide details.

_____

_____

_____

13.0 ABS Systems Maintenance Policy

If a unit's ABS system is defective, please indicate, on the basis of your fleet's policy and procedures, when the situation was to be corrected.

Prior to the unit's next dispatch ☐

Within a period of: 1 day ☐ 1 week ☐ 1 month ☐

At the unit's next scheduled maintenance ☐

14.0 ABS Systems Operational Performance

Please rate the following aspects of ABS systems performance based on your fleet's experience and driver reports during the last six months.

		High	Satisfactor	Low	Inadequate	No Opinion
14.1	Reliability of ABS systems to consistently perform as expected during vehicle operation.	☐	☐	☐	☐	☐
14.2	Reduction of vehicle stopping distance under severe brake application and slippery pavement conditions.	☐	☐	☐	☐	☐
14.3	Increase in vehicle stability during brake application under slippery pavement conditions.	☐	☐	☐	☐	☐
14.4	Adequacy of Warning Light in keeping driver aware of ABS system operational status.	☐	☐	☐	☐	☐
14.5	Reduction in premature tire wear by the prevention of tire "Flat Spotting".	☐	☐	☐	☐	☐
14.6	Reduction in brake system wear and maintenance.	☐	☐	☐	☐	☐

Please provide further comments if necessary.

_____

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_____

15.0 Durability of ABS Systems

Please rate the durability of this equipment based on its trouble free operation and/or its maintenance requirements.

High ☐ Satisfactory ☐ Low ☐ Inadequate ☐

No Opinion ☐

16.0 ABS Systems Maintenance Requirements

Please indicate ABS maintenance requirements by writing in the appropriate boxes below the total numbers of maintenance activities performed on all ABS equipped fleet vehicles. You are asked to provide a breakdown of these activities by System Component, Cause of Failure and Nature of Repair.

Failed Component of ABS System	Numbe	Source / Cause of Component Failure	Numbe	Nature of Maintenance Activity	Numbe
ECU	☐	Equipment failure External damage	☐ ☐	Adjustment Repair Replacement	☐ ☐ ☐
Speed Sensors	☐	Equipment failure External damage	☐ ☐	Adjustment Repair Replacement	☐ ☐ ☐
Pressure Modulating Valves	☐	Equipment failure External damage	☐ ☐	Adjustment Repair Replacement	☐ ☐ ☐
Cables & Connectors	☐	Equipment failure External damage	☐ ☐	Adjustment Repair Replacement	☐ ☐ ☐
Warning Light	☐	Equipment failure External damage	☐ ☐	Adjustment Repair Replacement	☐ ☐ ☐

Please provide further comments if necessary.

17.0 Availability of ABS Parts, Service and Technical Support

	Excellent	Good	Poor	Very Poor	No
17.1 Please rate, on the basis of global fleet experience with ABS systems during the last six months, the availability from ABS systems manufacturers and distributors of the following:					
Replacement parts	☐	☐	☐	☐	☐
Specialized maintenance equipment	☐	☐	☐	☐	☐
Maintenance service and assistance	☐	☐	☐	☐	☐
Technical support	☐	☐	☐	☐	☐
Training programs for mechanics	☐	☐	☐	☐	☐
17.2 Please rate the availability in your area(s) of operation of the following:					
Adequately trained maintenance personnel	☐	☐	☐	☐	☐
Specialized maintenance shops	☐	☐	☐	☐	☐

Please provide further comments if necessary.

_____

_____

_____

_____

18.0 ABS Maintenance Complexity

Please indicate the perceived level of complexity of ABS system maintenance.

	by Fleet Management	by Vehicle Maintainers
Very complex	☐	☐
Relatively complex	☐	☐
Relatively simple	☐	☐
Simple	☐	☐
No opinion	☐	☐

Please provide further comments if necessary.

_____

_____

_____

_____

19.0 Impact of ABS Systems on Vehicle Purchase Prices

Please indicate, on the basis of your more recent purchases of vehicles, the impact of ABS systems on vehicle purchase prices. Indicate this as a percentage of additionnal ABS system cost over the purchase price of an identical vehicle without ABS. Use an average figure based on the types of units in your fleet.

Less than 1% ☐ 1 % to 2% ☐ 2% to 5% ☐

5% to 10% ☐ More than 10% ☐

20.0 Impact of ABS Systems on Vehicle Maintenance Costs

Please indicate the impact of ABS systems on vehicle maintenance costs. Indicate this as a percentage of additionnal maintenance costs associated with ABS systems over the total maintenance costs (excluding vehicle down-time) of identical vehicles without ABS. Use an average figure based on the type of units in your fleet.

Less than 1% ☐ 1 % to 2% ☐

2% to 5% ☐ More than 5% ☐

Please provide further comments if necessary.

_____

_____

_____

21.0 Impact of ABS Systems on Total Vehicle Operating Costs

Please indicate your best overall estimate of the impact of ABS systems on total vehicle operating costs. An average figure should be given that is representative of the types of units in your fleet. Indicate this as the percentage of additionnal operating costs of the vehicle generated by ABS systems over the total operating cost (including all fleet management and overhead as well as vehicle down-time) of identical vehicles without ABS.

Less than 0,5% ☐ 0,5 % to 1% ☐ 1% to 2% ☐

2% to 5% ☐ More than 5% ☐

Please provide further comments if necessary.

_____

_____

_____

22.0 Further Comments and Information on ABS Systems

Please use this page and, if necessary, additionnal pages to provide further comments and information on ABS Systems and issues you believe need to be further addressed, that you consider pertinent to this survey and its stated objectives.

APPENDIX B

LIST OF RESPONDENTS

Appendix B

List of respondents

The following is the list of the fleets that graciously participated in this survey by providing answers, comments and information on the basis of their practical in-service experience with ABS systems installed on their vehicles.

The Transportation Development Centre, Groupe Cartier, and the authors of this report gratefully acknowledge their participation which made this survey possible and contributed to the general availability of data on ABS systems and particularly on their impact on road safety as well as on vehicle operation, maintenance and related costs.

TRUCKS:

A. Sokil Transportation Group
8830 - 126 Ave.
Edmonton, AB T5B 1G9
T 403 479-1981

B. Levy Transports Ltée
1950, 3 ième rue
Saint-Romuald, Quebec G6W 5M6
T 418 834-4400

C. Canadian Liquid Air
1250 Boul. Rene-Levesque,
Montreal, Quebec H3B 4W2
T 514 499-8088

D. Challenger Motor Freight
410 Queen Street W.
Cambridge, Ontario N3C 1G9
T 519 658-5154

E. Midland Transport
New Brunswick
T 506 858-5555

F. Transpel
205, chemin du Tremblay
Boucherville, Québec J4B 6L6
T 514 641-9051

G. Transport Asbestos Eastern
405 Blvd. Industriel
Asbestos, Quebec J1T 4C1

T 819 879-6671

H. Trimac Transportation Services Corporation
2100, 800 - 5 Ave. S.W.
Calgary, Alberta T2P 2P9
T 403 298-5320

I. GLS LEASCO Canada
7234 Littlewood Drive
London, Ontario N6P 1J7
T 519 652-2832

BUSES:

J. PMCL
475 Bay St.
Midland, Ont. L4R 1L1
T 905 526-0161 ext. 325

K. Classic Limousine
8675 Bernard St.
Vancouver, BC V6P 5G6
T 604 267-1441